Predation of Salmonid Smolts by Harbor Seals in Quilcene Bay, Washington

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April, 1990

Introduction

Since 1980 the U.S. Fish and Wildlife Service has been attempting to establish a hatchery run of spring chinook salmon (Oncorhynchus tsawytscha) at the Quilcene National Fish Hatchery. The primary motivation was that restoration of depleted Pacific anadromous salmonid stocks were a high Service priority and most Puget Sound spring chinook runs were depleted if not eliminated. Thus one Service objective was to establish a self-sustaining spring chinook hatchery stock which could later be used as a broodstock source for reestablishing runs in other Puget Sound streams (U.S. Fish and Wildlife Service 1980). Through a combination of difficulties, the Quilcene spring chinook run has failed to become self-sustaining (Hiss et al. 1988). A primary reason for continued low escapement to the hatchery is low survival after the yearling smolts are released from the hatchery (Hiss et al. 1988). One possible source of mortality is predation soon after release from the hatchery. Kenworthy et al. (1985) indicated that smolts were heavily preyed upon by seabirds especially if smolts reached the estuary at low tide. Since then, releases have been timed so the majority of smolts reach the estuary at high tide.

Another possible explanation for low spring chinook salmon survival, as measured by coded-wire tagging (CWT), is potential predation by harbor seals (Phoca vitulina) residing near the Quilcene River mouth. Calambokidis and McGlaughlin (1987) observed a maximum density of 230 harbor seals in Quilcene Bay during regular censuses in 1985 and 1986. Although harbor seals are generally thought to feed mostly on flounder, sole, sculpin, hake, cod, herring, squid, and octopi, they are also considered opportunists (Jeffries and Newby 1986) so may well consume salmon smolts when available in great abundance as when released from hatcheries. Calambokidis et al. (1978) concluded, based on the presence of fish otoliths in seal scat, that Puget Sound harbor seals primarily ate hake (Merluccius productus) and reported no salmonid otoliths. It is possible, however, that salmonid smolt otoliths were overlooked in those samples because of their small size or because they were partially digested in seal stomachs.

The objective of this study was to determine whether seals preyed on smolts as they emigrated from the Quilcene River. Although the primary species released in the Quilcene River were spring chinook and coho salmon (O. kisutch) and therefore the focus of this study, some chum salmon (O. keta) and steelhead (O. mykiss) were also released.

Methods

Hatchery smolts were released into the Quilcene River in 1988 by both the U.S. Fish and Wildlife Service and the Washington Department of Wildlife (Table 1). We observed seal behavior to determine whether seals were preying on salmonid smolts in the Quilcene estuary. We had planned to supplement this information with analysis of seal scat for evidence of salmonid smolt consumption but were unable to collect scat from the Quilcene Bay haulout site as planned.

Behavior.- Initial field reconnaissance revealed that the Quilcene River mouth and the primary Quilcene Bay haul-out site could both easily be observed from a bluff on East Quilcene Road using binoculars and/or a spotting scope. A map of Quilcene Bay (Figure 1) served as a basic field sheet on which observations for various behavior types were recorded. Each observation trip was recorded on one map. By studying behavior patterns before, during, and after smolt releases, conclusions were made regarding possible changes in feeding behaviour in response to smolt releases. A basic untested assumption of this approach was that seals observed actively feeding in proximity to the river mouth were feeding on smolts. Since almost all salmonid production in the Quilcene system is hatchery-based, the only smolts expected were those listed in Table 1.

Scat analysis.- Beginning before smolts were released, several attempts were made to collect seal scat from log rafts used as the primary haul-out site in Quilcene Bay. Because seals hauled out on older log booms which were smoothed from age and abrasion, no scat samples could be collected at the Quilcene site. This same problem had been experienced in previous years by Cascadia workers. Coincidentally, Cascadia Research Collective was conducting another study which included collection of scat samples from the Dosewallips River mouth. Experience led us to believe that seals regularly moved back and forth between Quilcene and Dosewallips River mouths. Thus, scat samples from the Dosewallips were analyzed for coded-wire tags and otoliths from Quilcene River salmonid smolts. Dosewallips scat samples were collected on May 2 and 16, June 19 and 20, and July 24, 1988.

Since all Quilcene Hatchery spring chinook had been coded-wire tagged, recovery of tags in seal feces would provide direct evidence of predation. All scat samples were tested for tags by passing each sample through a magnetic detector.

Scat samples were also inspected for presence of salmonid otoliths and other bones by sieving scat through a series of screens. Organic material in the samples was washed with warm-water spray through the sieves leaving otoliths and other bones. The screen mesh sizes were 2 and 1 mm for samples processed before June 1. We added a 0.5-mm screen after June 1 because otoliths, removed from samples of spring chinook and coho salmon taken from the raceways of Quilcene Hatchery the day before smolts were released, were small enough to potentially pass through the 1-mm screen. These sample otoliths were also used as keys to indicate whether target otoliths were being recovered in scat samples.

After keying otoliths to species (using Morrow 1979, Frost 1981, and a reference collection developed by the late John Fitch, California Fish and Game Department), the greater number of any left or right salmonid otoliths were planned to be recorded for each sample. According to Harvey (1987), approximately 50% of Salmo gairdneri smolt otoliths were recovered from harbor seal scat on the average. Thus, the greater number of otoliths observed in each sample was planned to be doubled to estimate the total salmonids represented in that sample.

Results and Discussion

Behavior.- Twelve observations were made from the bluff on East Quilcene Road before, during, and after smolts emigrated from the river (Table 2). The general pattern of seal movements in Quilcene Bay apparently depended on the tidal cycle. Seals only hauled out on the log rafts at high tide because upper reaches of the bay, where the rafts are located, are exposed or very shallow at low tide. As the tide ebbs, seals enter the water en masse either when disturbed or of their own volition. The vast majority move southward toward the mouth of Quilcene Bay in loose aggregation. No conclusive observations were made on the pattern of return to the area or hauling out.

Seals apparently fed on salmon smolts on May 11 and 12, the days after coho and spring chinook salmon smolts were released from the hatchery (Figure 2). However, even though some seals were observed feeding at the river mouth, the majority of Quilcene seals remained hauled out at the same time or were observed moving south toward the mouth of Quilcene Bay and away from the river mouth (Table 2). The implications of these observations are that, while there is some apparent predation by seals, the relatively small numbers of seals actually feeding probably cause only a small loss relative to the entire smolt population. In fact, 150-250 gulls and 8-10 great blue herons were observed actively feeding on smolts during the three observations conducted while smolts were emigrating from the river. We estimate that during the observation period, birds caused more substantial smolt losses than did seals.

On the afternoon of May 11, we conducted a snorkle survey in the Quilcene River and directly counted coho and spring chinook salmon smolts. We estimated that, having seen at least half the smolts remaining in the river, about 51,000 coho and 21,000 spring chinook salmon smolts remained in the river. This meant that approximately 236,000 coho and 116,000 spring chinook salmon smolts had emigrtaed to the estuary since they were released the previous evening and had not residualized in the river. Smolts probably remained in Quilcene Bay no more than several days based on limited observations by Kenworthy et al. (1985).

A serendipitous observation potentially having more serious implications was made on the afternoon of May 11. Three seals near the Quilcene River mouth were observed fighting over a large-sized adult fish. Although not positively identified as a salmonid, it was of the correct body form and size to likely be a spring chinook salmon or steelhead. Previous work (Brian McGlaughlin, Cascadia Research Collective, personal communication) has indicated that seals prey on adult salmon as they enter the Dosewallips River. Brown and Mate (1983) also reported that up to 7.2% of the total chum return to a hatchery on Whiskey Creek, Oregon was preyed upon by harbor seals. Any loss of adult spring chinook is very significant considering the extremely slow rebuilding of the Quilcene run. If predation of adults is extensive, it could potentially explain a large portion of the observed low marine survival.

Scat analysis.- No coded-wire tags were found in 21 Dosewallips samples analyzed for tags. We would not conclude, however, especially given the evidence obtained in behavior analysis, that seals were not consuming smolts. Several sampling artifacts could have biased our results. One is that scat

collected at Dosewallips River does not necessarily reperesent food eaten at Quilcene. The other is the relatively small sample size.

No salmonid otoliths were recovered from the 21 samples collected at Dosewallips. In fact, scat analysis verified hake as the primary food of seals (Calambokidis et al. 1989). However, there was too little data collected too far from Quilcene to conclude from scat analysis that seals do not eat salmonid smolts.

Conclusions

There were too few observations in this study to draw firm conclusions. However, we believe that harbor seals may be preying on salmonid smolts although probably not to an extent detrimental to the population. A more significant problem may be predation on adult chinook returning to the Quilcene River; this potential problem should be further studied.

Acknowledgements

We thank Russ Ferg, manager of Quilcene National Fish Hatchery, for coordinating his schedule with our needs and for providing relevant information. Joe Hiss conducted the snorkeling to determine smolts remaining in the river. Brian McGlaughlin collected scat samples and Gretchen Steiger processed them. Phil Wampler prepared the graph.

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Table 1. Date of smolt releases, and size and number released, in the Quilcene River, Washington, during 1988.

Date	Species	Approximate size at release (cm)	Number
April 18	steelhead	20.3	5,000
April 28	chum	5.0	2,182,147
May 10	spring chinook	13.7	137,596
May 10	coho	11.7	287,085
May 11	coho	11.7	287,085

Table 2. Observations of seals on log rafts and near the mouth of the Quilcene River from East Quilcene Road in 1988.

Date	Time	Weather	Relative tide	Seals hauled out	Seals near river mouth	Apparent behavior
April 9	1300	clear	mid-ebb	6	0	-
April 9	1715	clear	low	0	0	-
April 17	0830	cloudy	mid-ebb	15	0	-
April 17	1730	cloudy	high	18	0	-
April 18	1830-1900	clear	high	6[a]	0[a]	-
May 8	0930-1000	ptl cldy	high	54	2	resting
May 11	0615-0715	ptl cldy	mid-ebb	26	5	feeding
May 11	1400-1430	clear	high	0	10	feeding
May 12	0550-0630	ptl cldy	mid-ebb	79	15	feeding
May 29	0540-0650	ptl cldy	mid-ebb	140	3	feeding
May 29	1530-1550	clear	high	6	4	feeding
May 30	0520-0645	ptl cldy	mid-ebb	185	2	feeding

[a] People working on log rafts

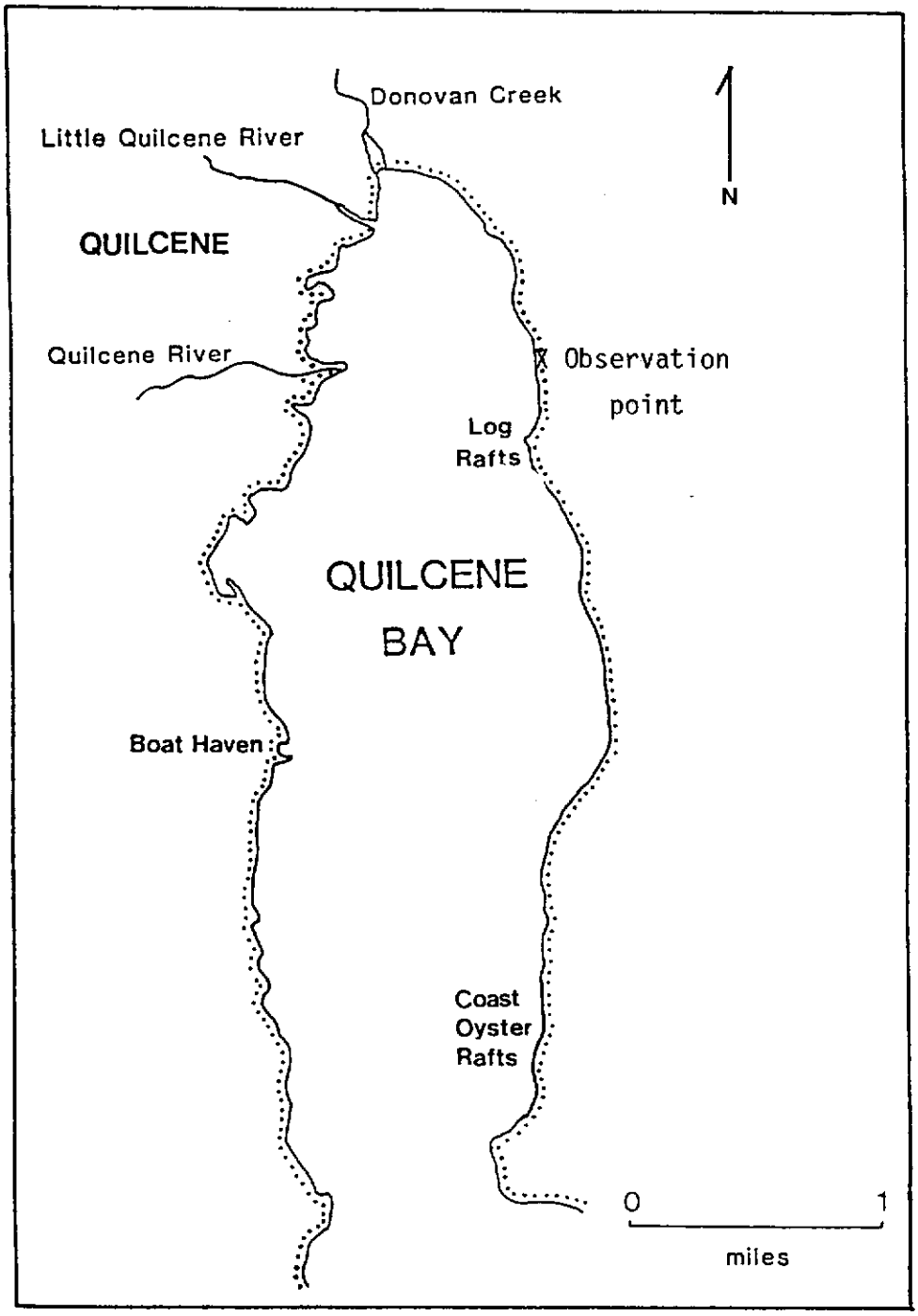


Figure 1. Quilcene Bay, Washington, showing location of river mouth, log rafts, and observation point.

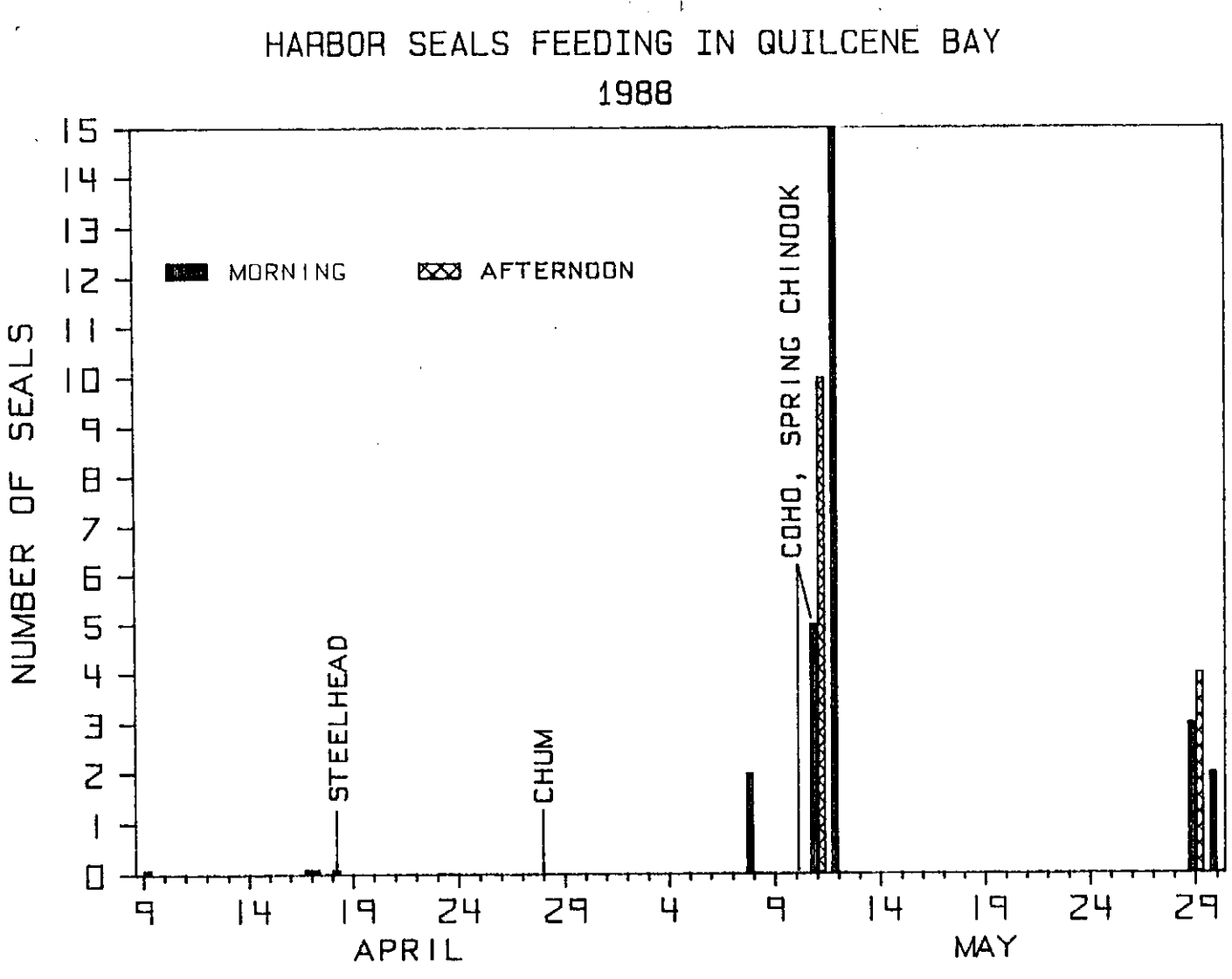
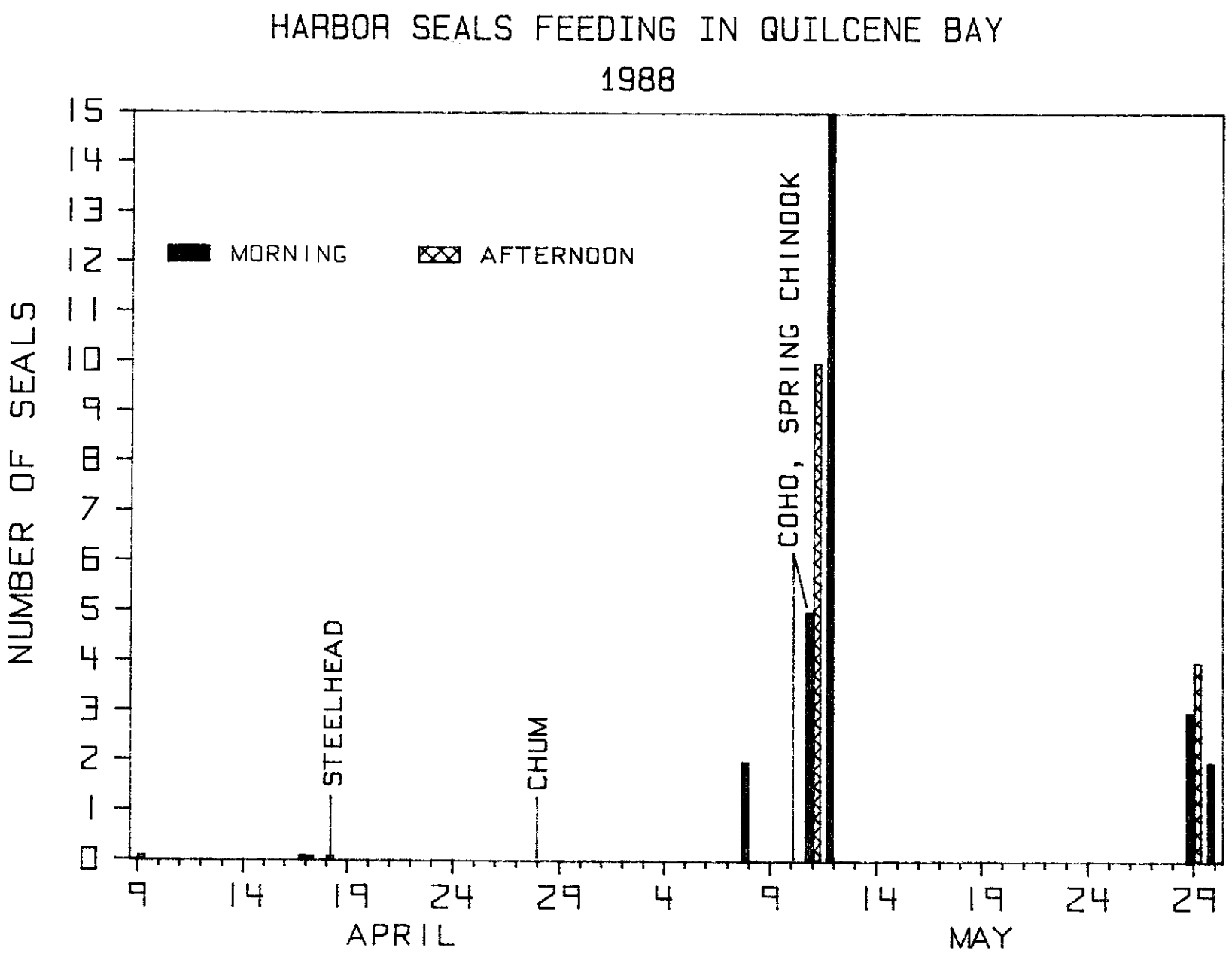
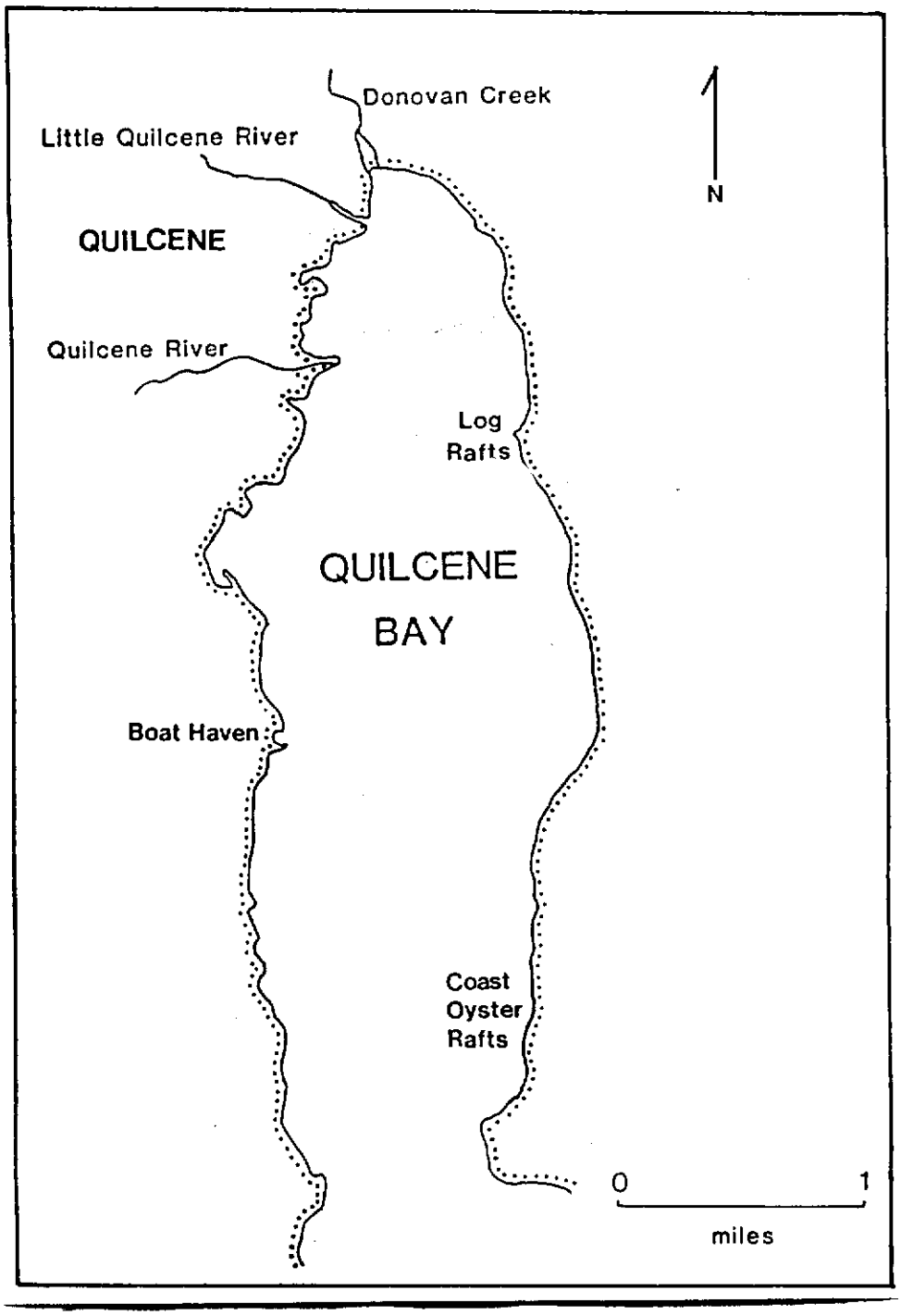


Figure 2. Observations of the number of seals feeding near the mouth of Quilcene River. Days of observation are designated by histograms with zeros represented as tiny histograms. Releases of smolts are represented by the species name with a line indicating the day of the release.


HARBOR SEALS FEEDING IN QUILCENE BAY
1988
NUMBER OF SEALS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
MORNING
AFTERNOON
STEELHEAD
CHUM
COHO, SPRING CHINOOK
9
14
19
24
29
4
9
14
19
24
29
APRIL
MAY



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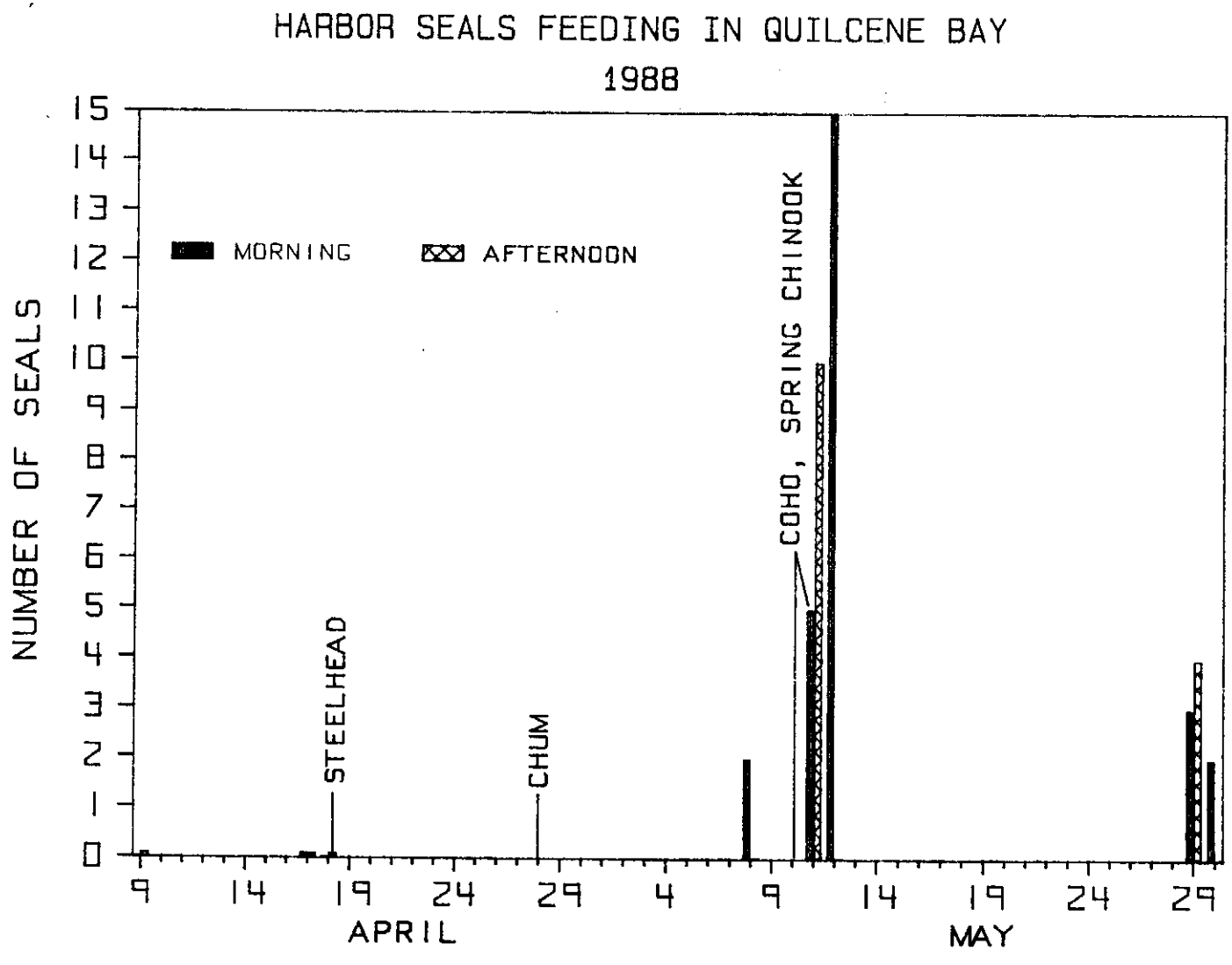

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